Human Immunology and Osmolality: An Hypothesis

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Maintenance of efficient body immune function is essential for successful long-duration spaceflight. Physical exercise training is employed on extended flights to counteract some aspects of weightlessness deconditioning. Exercise also influences the immune system: performance of moderate exercise increases many immune parameters in the blood, while heavy exercise depresses immune function.

However, the mechanism of these exercise-induced immune responses, particularly those involving the white blood cells (WBC, leucocytes) and platelets (Plat, thrombocytes), is not clear. Prior hypotheses have implicated plasma catecholamines (epinephrine, norepinephrine), cardiac output (blood flow), increased rectal temperature (Tre), and changes in plasma volume (PV), with no agreement on the major factors or their possible integrative effect on immune function.

Experimental data from Ames Research Center have indicated that plasma osmotic concentration [Osm] is highly correlated with responses of the WBC and Plat during exercise, but not at rest, as shown in part (a) of the figure. During exercise, the high, significant correlation coefficients (r) between [Osm]

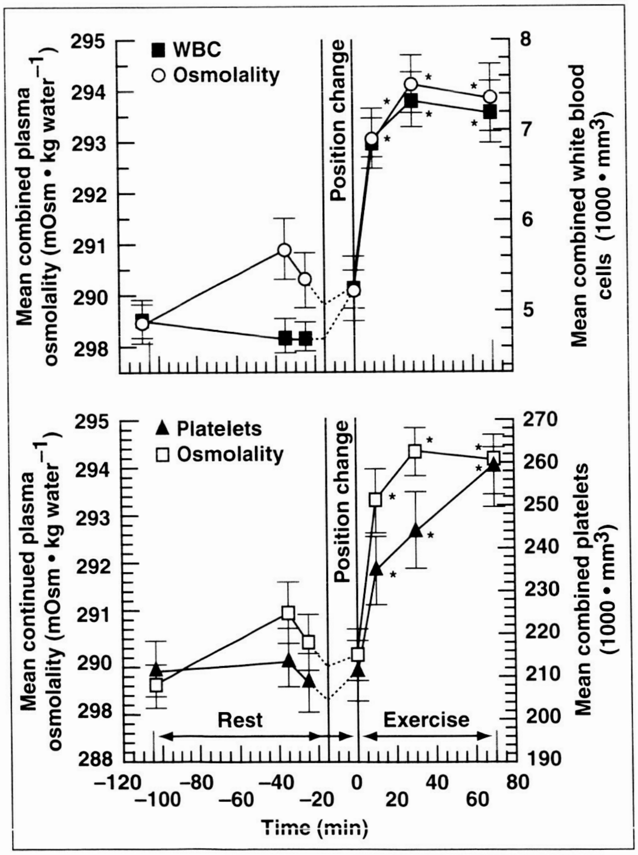

Fig. 1(a). Upper panel: Mean (standard error) plasma osmolality and white blood cells at rest and during exercise in six untrained men (22–39 years). Lower panel: Mean (standard error) plasma osmolality and platelets at rest and during exercise.

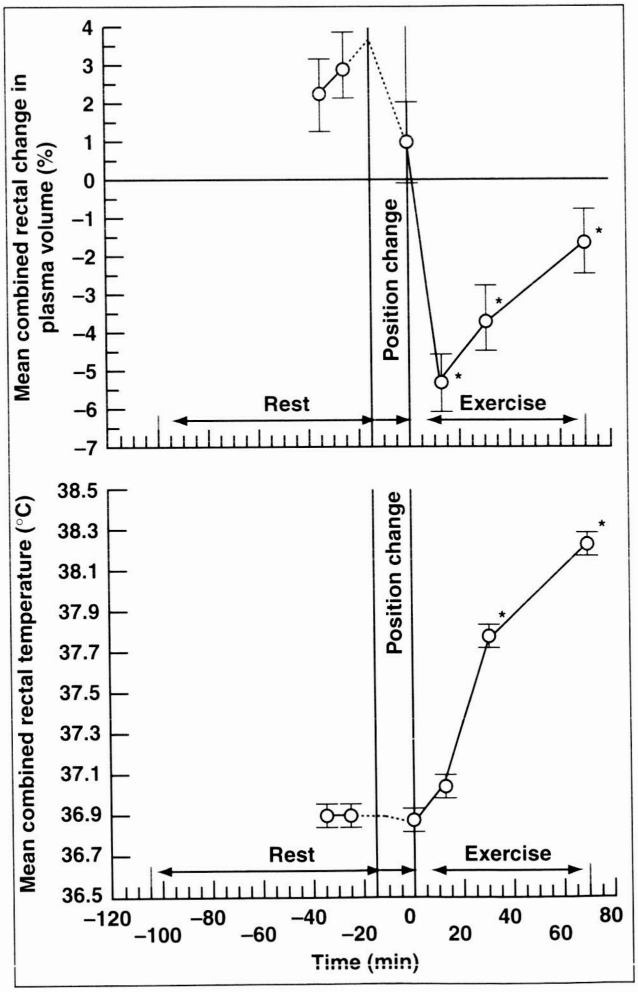

Fig. 1(b). Mean (standard error) percent change in plasma volume (upper panel), and rectal temperature (lower panel), at rest and during exercise in six men.

and WBC (r = 0.95, $p < 0.001$), and [Osm] and Plat (r = 0.94, $p < 0.01$), indicate that the leucocytes, thrombocytes, and hyperosmolality occur primarily within the first 10 minutes of moderate (71% of the maximal intensity) exercise. Neither the decrease in PV nor the increase in Tre during exercise, as shown in part (b) of the figure, were involved because all respective correlation coefficients between percent change in PV and Tre and WBC, Plat, and [Osm] were less than 0.2 (nonsignificant).

Thus, these high correlations, between [Osm] and WBC or Plat, suggest the hypothesis that changes in plasma osmolality may contribute to the mechanism of leucocytosis and thrombocytosis induced by exercise.

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Neurolab Technologies Enable Space Life Sciences Neuroscience Research

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The Shuttle Spacelab mission, Neurolab, was the primary focus for the flight support elements of the Life Sciences Division, the Payload and Facilities Engineering Branch, and the Science Payloads Operations Branch. First conceived in 1993, and launched just five years later, Neurolab evolved into the most complex Spacelab mission ever developed by Ames Research Center (ARC). Though the major hardware units had flown previously (for example, the general purpose work station (GPWS), the research animal holding facilities (RAHFs), and the animal enclosure modules (AEMs)), critical modifications were carried out to ensure that the hardware would meet the Neurolab science objectives and improve overall technical capabilities.

The monitoring and process control subsystem (MPCS) was a new element incorporated into the RAHFs. The MPCS is a microprocessor-based process and control system housed in a standard interface rack (SIR) drawer. It replaces both the RAHF upper and lower electronic boxes used on previous flights for environmental system control, RAHF system monitoring, and data retrieval. Consolidation of these functions into a single unit was intended to improve maintainability, increase thermal and power efficiency, add system diagnostic capabilities, improve remote ground monitoring and control, and reduce the overall required rack space. Additionally, incorporation of the MPCS in the SIR drawer ensured its compatibility with future International Space Station experimental systems. Because the Neurolab science objectives required the housing of neonate rats, some RAHF cages were modified to accommodate nursing dams and neonates. A middeck flight with rat neonates on STS-72 in January 1996 was a research "first" by the Ames Life Sciences Division that helped prepare for the sophisticated experiments on Neurolab.

The AEMs, which were previously flown on 20 Shuttle missions and designed for hands-off protocols, were modified for in-flight access to animals. Access and transfer schemes proposed for use on Neurolab were first tested in the parabolic arc environment aboard a KC-135. The AEM lid and transfer unit modifications greatly expanded the science that is possible using this middeck rodent facility (see the first figure). The improved AEM may

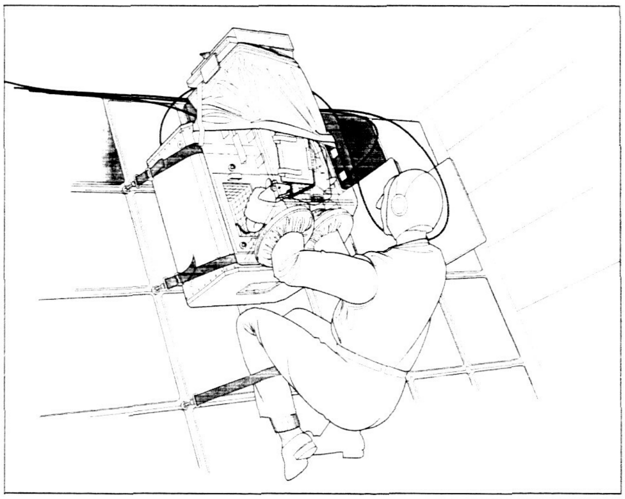

Fig. 1. Crew person at animal enclosure module with modified lid and transfer unit allowing middeck animal access.